Low-temperature intracrystalline deformation microstructures in naturally deformed quartz, haven't you noticed them in your samples?

Tine Derez[1], Gill Pennock[2], Martyn Drury[2] and Manuel Sintubin[1]

[1]*Geodynamics and Geofluids Research Group, Department of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200E, B-3001 Heverlee, Belgium.*

tine.derez@ees.kuleuven.be

[2]*Faculty of Geosciences, Department of Earth Sciences, Utrecht University, Budapestlaan 4, 3508 Utrecht, The Netherlands.*

With an estimated presence of 62%, quartz is the most common mineral in the continental crust. The understanding of the deformation properties of quartz is therefore crucial in understanding the rheological behaviour of the continental crust. Although quartz is considered to be one of the best-known minerals concerning its nature of deformation, it is still contentious to unequivocally interpret deformation microstructures with respect to deformation conditions and mechanisms.

Inconsistent use of terminology and the use of genetic terminology makes it very difficult to correctly assess all observations and genetic interpretations in published material. A large variety of models for the formation of low-temperature intracrystalline deformation microstructures has been suggested. Contradictions between the models show that their validity is still ambiguous and that there is probably no unique interpretation, as the microstructures depend on many ambient conditions as temperature, strain, strain-rate, crystallographic orientation with respect to the stress state, stress level, pressure, presence of fluida, etc.

Moreover, these intracrystalline deformation microstructures have been observed in experimentally and in naturally deformed quartz. There is, however, still a need for more detailed observations in quartz deformed in a larger range of natural conditions, in order to properly correlate experimental conditions with conditions in the Earth's crust.

The low-temperature deformation microstructures referred to, are commonly observed with optical microscopy: (1) zones with a misorientation of less than 10° to the host crystal, that often contain fluid inclusions along their boundaries; (2) narrow (<2µm thick), lenticular planar elements that have a misorientation around 2° to 5° with the host crystal, that can be undulatory and wavy and occur in closely spaced, parallel sets with a close spacing around 4-5µm; (3) elongate bands with undulose extinction, up to 100µm in width, that have a misorientation with the host crystal between 5° and 10° and are mostly elongate parallel to the optical c-axis; (4) conjugate strings of square to rectangular zones, around 20-30µm in width, in which the misorientation (up to 60°) with the host crystal is in an opposite direction with respect to the host crystal; (5) conjugate anastomosing narrow zones, around 5µm in width, in which the misorientation (up to 60°) with the host crystal is in an opposite direction with respect to the host crystal, containing a high amount of decrepitated fluid inclusions.

We propose to name these features (1) subgrains, (2) fine extinction bands, (3) wide extinction bands, (4) blocky strings and (5) straight strings. We prefer this more descriptive terminology than the wide variety of names that is currently being used. For example, the wide extinction bands have been called deformation bands, prismatic kink bands and type II kink bands. Additionally, extensive use of microphotographs is imperative for accurate correlation between different studies. Because a picture is worth a thousand words!